On The Great M-Disc vs. “Regular” Blu-Ray Debate

My attempt to get to the heart of the surprisingly fierce online debate as to which form of optical media storage is the best for long term offline archival storage

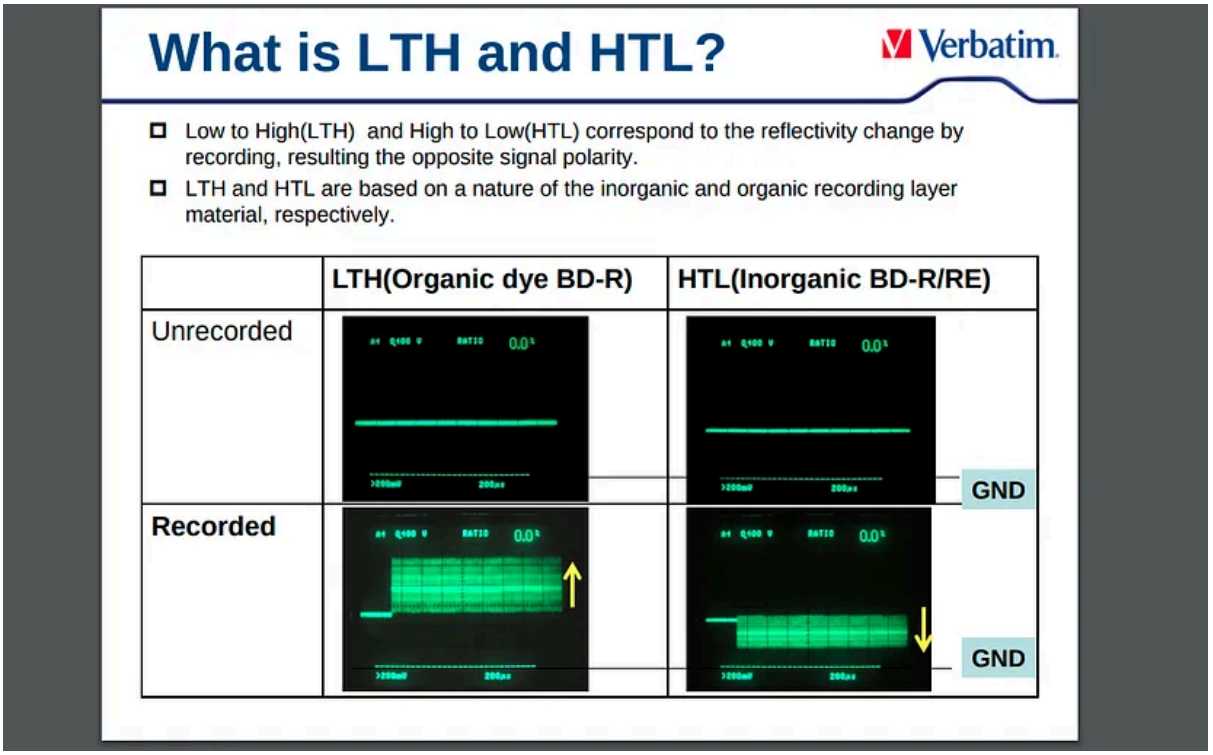
So last week I posted a support response that I received from Verbatim regarding whether their currently produced Blu Rays are HTL (high to low) or LTH (low to high). Unfortunately in attempting to clarify this subject I did the exact opposite.

Hence my attempt to start a new thread from scratch.

Although these differences might seem trivial, to those who have placed their data and trust in optical media for archival purposes (and thus expect reasonable longevity from the media) this stuff is actually data-critical.

Hence I’m investing some time and effort in trying to get to the bottom of things.

LTH vs HTL



A Verbatim company presentation outlining the differences between Blu Ray LTH and HTL technology.

Let's start with what's uncontroversial:

- **LTH = low to high = recording layer is organic (like CDs and DVDs).** BD-R LTH was attractive to the storage industry and they could only slightly modify existing CD and DVD production lines to churn out this media.
- **HTL = high to low = recording layer is inorganic (like M-Discs).** In Verbatim world, HTL involves the use of MABL (metal ablative recording layer). But MABL is not the only possible implementation of an inorganic recording layer for BD-X media.

Verbatim's description of how its MABL technology works. Source: Verbatim.

Here's how Verbatim describe MABL (I'm quoting verbatim — pardon the pun — from their marketing literature):

"MABL: A specially created inorganic recording layer present on Verbatim's BD-R media ensures excellent recording compatibility and prolonged stability for archival life."

Organic dyes — including AZO — are subject to ageing and deterioration. Dye degradation leads to lack of optical contrast which leads to lost data. It's widely believed that inorganic recording layers offer superior longevity (for MABL, I've heard 300 years thrown about. Mdisc famously claims a millennium.)

This doesn't mean, by the way, that inorganic recording layers are guaranteed to be impervious to data loss.

M-Discs's product literature suggests that the polycarbonate substrate may be a more vulnerable failing point than the recording layer itself.

Presumably inorganic layers can degrade in other ways that would reduce the all-important optical contrast which holds the key to data preservation on optical media.

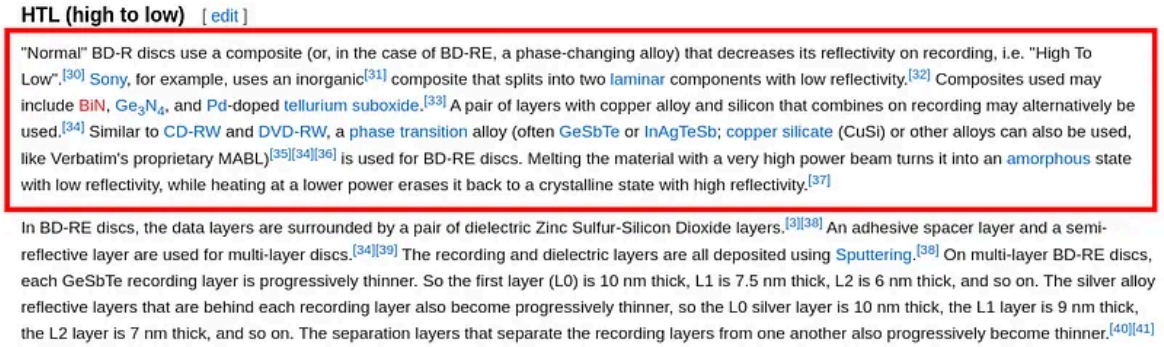
But it seems reasonably widely agreed-upon that inorganic layers including metal alloys are overall better primed for the job of staying physically inert over time than their organic counterparts.

HTL / Inorganic Blu Rays vs. M-Discs

And here's what I can surmise on this particularly controversial topic:

To the extent that the M-Disc and HTL Blu Rays are different, the differences probably have to do with differences in the composition of the inorganic layer.

Even researching this subject briefly, you can find resources pointing to different alloys and composites that different manufacturers have used in their Blu-Ray products intended for archival.



HTL (high to low) [edit]

"Normal" BD-R discs use a composite (or, in the case of BD-RE, a phase-changing alloy) that decreases its reflectivity on recording, i.e. "High To Low".[30] Sony, for example, uses an inorganic[31] composite that splits into two laminar components with low reflectivity.[32] Composites used may include BiN, Ge_3N_4, and Pd-doped tellurium suboxide.[33] A pair of layers with copper alloy and silicon that combines on recording may alternatively be used.[34] Similar to CD-RW and DVD-RW, a phase transition alloy (often GeSbTe or InAgTeSb; copper silicate (CuSi) or other alloys can also be used, like Verbatim's proprietary MABL)[35][34][36] is used for BD-RE discs. Melting the material with a very high power beam turns it into an amorphous state with low reflectivity, while heating at a lower power erases it back to a crystalline state with high reflectivity.[37]

In BD-RE discs, the data layers are surrounded by a pair of dielectric Zinc Sulfur-Silicon Dioxide layers.[3][38] An adhesive spacer layer and a semi-reflective layer are used for multi-layer discs.[34][39] The recording and dielectric layers are all deposited using Sputtering.[38] On multi-layer BD-RE discs, each GeSbTe recording layer is progressively thinner. So the first layer (L0) is 10 nm thick, L1 is 7.5 nm thick, L2 is 6 nm thick, and so on. The silver alloy reflective layers that are behind each recording layer also become progressively thinner, so the L0 silver layer is 10 nm thick, the L1 layer is 9 nm thick, the L2 layer is 7 nm thick, and so on. The separation layers that separate the recording layers from one another also progressively become thinner.[40][41]

So what's 'marketing speak'? What's legit?

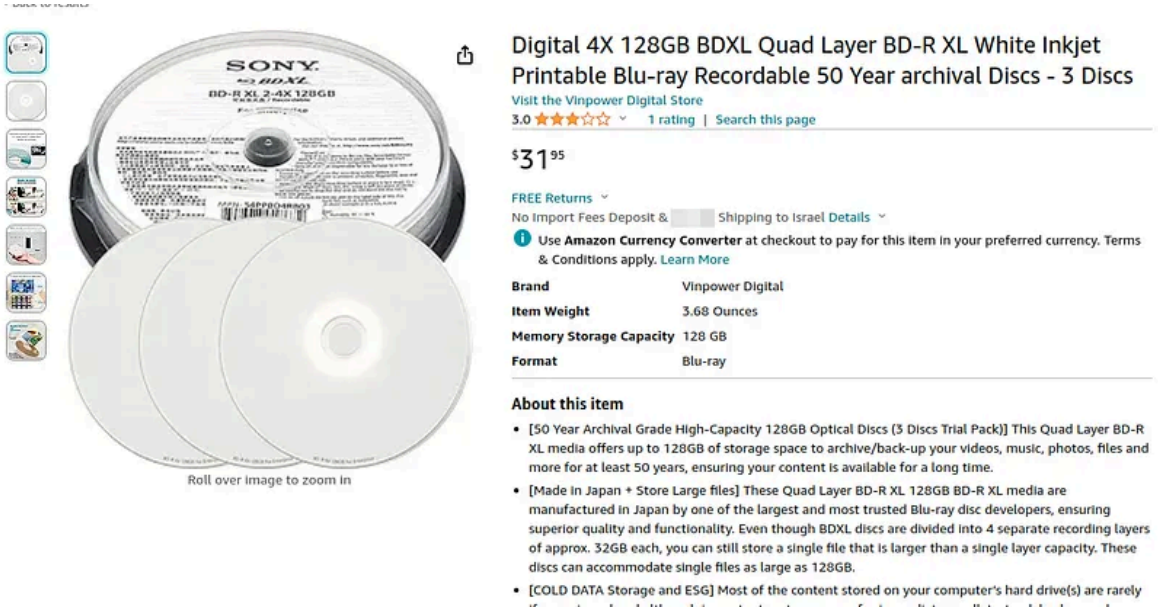
The only truthful answer as far as I can tell is "nobody knows."

The M-Disc BD-R came to market in 2014, 10 years ago. At the time I'm writing this, we'd need to hop into a time machine and teleport 990 years into the future to test whether that claimed longevity was accurate.

Is whatever's in the M-Disc truly better than whatever's in Verbatim's "regular" BD-R with MABL?

I suggest that it's reasonable to assume that there's at least some difference between these two products and for a very simple reason: It wouldn't make sense for Verbatim to maintain the Verbatim M-Disc and regular Verbatim (HTL) BD-Rs as concurrent product lines if there were truly no differences between the two.

Of course, Verbatim could be an evil corporation intent on duping us optical media diehards. But I would suggest that unless somebody can prove that to be the case by examining the products' material composition at the microscopic level that … this level of skepticism and cynicism may be unwarranted (to put it mildly).



And what about the archival BD-Rs that Sony, JVC, Panasonic, and others have brought to market? Aren't these also engineered with inorganic recording layers? Yes they are!

I suggest that all any of us can do is evaluate the technology on the basis of the best information available to us. Even if we were privy to the exact formulations of nanomaterials used in rival products, I'd suggest that this information wouldn't take us much further to the truth in trying to discern which product is the very best (because we'd still have to rely on the extrapolated calculations of accelerated ageing tests to determine truths).

Might the most simple and reasonable advice be "pick a brand you like and trust and hope their claims live up to what's on the website?" It may actually be all any of us can do.

HTL vs. LTH Debate On Reddit

There have been much discussed threads on the /r/datahoarder subreddit alleging that all Blu Rays in circulation are low to high (LTH), organic media. So last week, I decided to reach out to Verbatim to ask whether their currently produced BD-R media is LTH or HTL.

Verbatim responded that they no longer make LTH Blu Ray media. Ie, all their Blu Ray media in production is HTL.

In retrospect, this seems to make abundant sense (and yes, assuming this is true, this means that the poster in the above thread is incorrect).

A couple of datapoints:

My current "regular Joe" Verbatim BD-Rs detect as HTL.

But more importantly it seems as if the manufacturers collectively did something of a rethink about the sagacity of trying to use organic dyes in Blu Rays.
The chronology of the evolution of consumer-purchasable and writeable Blu Ray media goes something — as far as I can discern — like this:

-> Blu-Ray was originally standardised on HTL

-> In 2009–2010 Verbatim launch BD-R LTH using AZO as the recording dye. This BD-R was often marketed as “Blu Ray LTH Type” to differentiate it from HTL which was the original and thus “standard” BD-R. BD-R LTH proved finnicky with burner firmware and perhaps anoraks like us didn’t like the regression that a move from inorganic to organic recording layers entailed.

-> In 20XX (I don’t know the date) Verbatim seems to have quietly shelved the LTH idea and went back to making BD-R HTL media.

-> In April 2014 Milleniata launches the first Blu Ray version of the M-Disc (25GB).

-> In December 2016 Milleniata files for bankruptcy.

-> 2016 — present: Milleniata licenses its technology to Verbatim and Ritek. Verbatim produces the M-Disc as BD-R, BD-DL, and BDXL (100GB). Ritek initially makes M-Disc DVDs and BD-Rs before focusing exclusively on Blu Rays. Verbatim never manufactured M-Disc DVDs.

So the trajectory of consumer-writable Blu Ray’s is essentially HTL -> LTH -> HTL (for the most part).

And at some point after we got back onto HTL the M-Disc came to market and was then subsumed into Verbatim’s product lines.

Verbatim (now a subsidiary of CMC) is of course only one of several disc manufacturers. You can still find BR-LTH discs on the market without too much trouble. Although I'm not sure why anybody would specifically want them.

My Closing Hot Take

All this detail and debate belies one very simple question: what's the very best physical form of digital storage medium that I can purchase in the year 2024 which will preserve my data in cold storage for the longest possible time?

And beyond verifying that any product has a reasonable probability of remaining free of data rot for say 50 years, I'd suggest that further enquiry is likely fruitless. For the following reason:

Realistically, stability of digital data beyond 100 years is likely not necessary.

Thus whether technology A vs B can guarantee archival life of 100 or 1,000 years is a moot point.

Since the advent of the digital age storage technology has rapidly evolved.

It’s reasonable to assume that the storage industry will have come up with a better solution for data permanence than Blu Rays in …. perhaps 30 years.

We hope and expect, of course, that this point will occur before the deprecation of optical media .. and that backward compatibility will enable us to get our stuff out of the old archival medium (Blu Ray) and onto its better successor … hopefully with vastly greater data densities.

I’ve heard it said frequently that LTO gets unreliable after about 30 years (max).

For cold data preservation longer than that, optical media is (weirdly) basically what’s out there.

Whether you’re putting your trust in archival grade CDs, DVDs, Verbatim BD-R or the M-Disc … we’ll do well to get 50 years of stable storage out of these things.

**All the above is correctly only to the best of my knowledge at the time of posting. This stuff certainly gets confusing. The definitive source of information about all this is probably the Blu Ray Alliance (BDA). Unfortunately getting hold of their disc specifications isn’t cheap.*